A MICROSPORIDIAN OCCURRING IN THE SMELT

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In the course of taxonomical studies on the smelts, Dr. A. C. Kendall and D. R. Crawford of the Bureau of Fisheries have frequently encountered a very characteristic infection in these fishes. This infection I find to be caused by one of the Microsporidia, belonging to the genus Glugea.

Infections at various stages of development were available. Apparently, the intestine is the primary seat of the parasite. Affected fishes are characterized by the appearance of more or less numerous cysts in the viscera, and generally all the cysts in a fish are of approximately the same size. The latter may vary from microscopical dimensions to 3 mm. in diameter. Early stages show them in the wall of the intestine where their white color makes them conspicuous even when still small. At this time they are located in the mucosa, below the epithelium of the villi (Fig. 2). As growth proceeds, they push through the muscular coat of the intestine, and then come to lie immediately under the peritoneum. An extreme but common manifestation of such cyst development is shown in Figure 1. The entire length of the intestine from below the stomach to within a short distance of the anus is here taken up with cysts, and it becomes a puzzle how it can function under such conditions. Cysts also occur in the liver and the gonads, but not one was found in the stomach proper, kidney or heart.

The distribution of affected smelts is a very interesting one. Such fishes were found in Lake Massabesic, N. H.; Sunapee Lake, N. H., near Dennysville on the extreme northern portion of the Maine coast, and Casco Bay on the southern Maine coast. The smelts in Sunapee Lake were introduced some years ago from Squam Lake, N. H., from which no records are available. It is to be noted that the specimens from the Maine coast are typical smelts which live in salt water and ascend fresh water streams at a certain time each year. Those from the lakes mentioned, however, are purely fresh water forms and never come in contact with salt water. Aside from other considerations, dams and other obstructions would make journeys from the sea into these lakes a physical impossibility. It may also be remarked that Dr. Kendall (paper in preparation) believes that these fresh water smelts are taxonomically distinct from the salt water form, *Osmerus mordax*.

Nevertheless, the Microsporidian parasites seem to be identical in both fresh and salt water smelts. Whether the parasite became estab-

lished after the several types of smelts had evolved, or whether it was present originally and underwent no morphologic changes in distinction to its host, must be left unanswered at present.

The rate of infection may be very high, as is manifested by the following data:

Lake Massabesic, N. H.: 38 out of 71 infected—over 53%. (Mild infections were not counted in this instance.)

Sunapee Lake, N. H.: 29 out of 103 infected—over 28%.

Dennysville, Me.: 1 out of 64 infected—over 1.5%.

Casco Bay, Me.: 48 out of 306 infected—over 16%.

In Casco Bay the distribution is very general, and affected fishes were caught at Mosiers Island and Freeport (Harraseeket River, Mast Landing Creek, and Porters Landing Creek). Collections were made in 1904, 1907, and 1915, and generally either in spring or autumn.

Adult fishes are only rarely parasitized, the highest rate of infection being found among immature fishes of approximately 10 cm. in length (generally speaking, about a year before maturity). Fishes of the latter size are very much more numerous than adults. Possibly the scarcity of parasitized adults is due to the fact that the majority of infected immature fishes die, leaving only those that escape infection to attain maturity. It must not be forgotten, of course, that such a disparity in the numbers of young and mature fishes is encountered to some degree in all other species of fishes, where parasitism may not be instrumental at all.

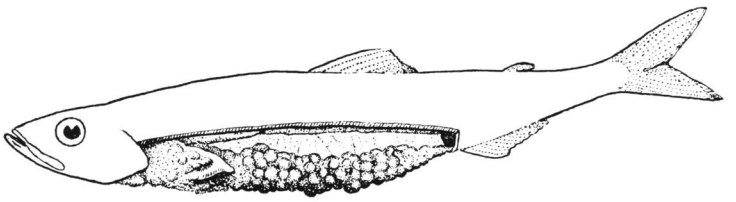
Glugea sp.

Cysts vary in size from microscopic dimensions to 2 or 3 mm. in diameter. As in other species of Glugea, sporonts, sporoblasts, and ripe spores may all be found in a single cyst, with the earliest stages near the periphery. Spore formation seems to follow the same lines as described for *Glugea anomala* by Stempell (1904), and Awerinzew and Fermor (1911).

Dimensions of spores: length = 4 to 4.5μ; width = 2 to 2.5μ.

The preservation of the material rendered a study of the nuclear conditions in the spores impossible, although other developmental stages were not badly fixed. The giant vegetative nuclei which have been the basis of much dispute, are very numerous at the periphery of developing cysts. To all appearances, they give rise to sporonts, as Stempell and Awerinzew and Fermor have maintained, and are not hypertrophied tissue nuclei of the host (Schuberg, 1910, and Schroeder, 1909).

Unlike *Glugea anomala,* the parasite is specific for the smelts and does not affect even other Salmonidae inhabiting the same waters. (It is indeed open to question whether the Microsporidia of Gasterosteus could be transmitted to Gobius, although Stempell believes that in both species of fishes, which are of widely different families, *Glugea anomala* is concerned.) Again, the size given above is fairly constant, and no such extreme variation as described in *G. anomala* could be



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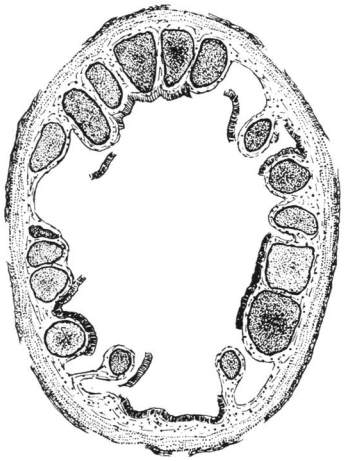

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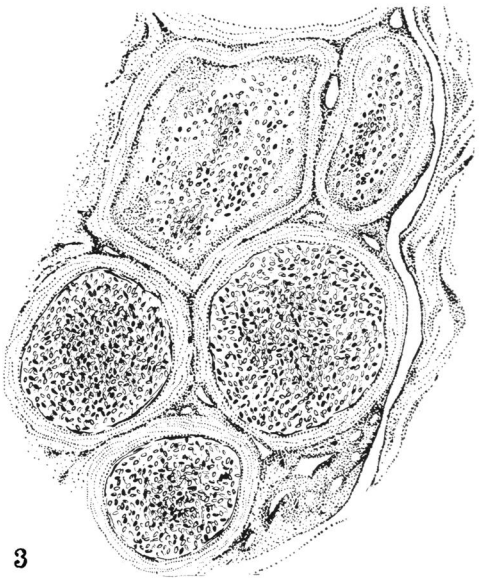

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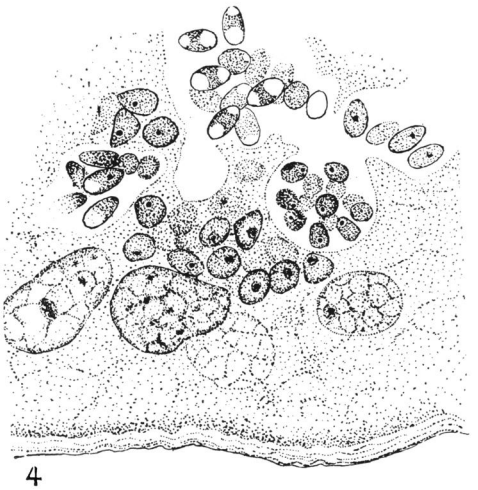

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PLATE XIV

observed. Muscles and connective tissue were found not to be subject to invasion, which also is a point of difference from that described species.

Microspore infections of the smelt have also been reported for North America by Mavor (1915) and Linton (1901). The latter records sporocysts in the intestine of this fish, but does not go into detail any more than Mavor, who contents himself with the statement that the microspore concerned in his case was apparently *Glugea stephani*. The measurements of the latter, which is typically a parasite of the flatfishes, differ definitely from the parasite which I have described—3 by 1.5 mm. (Johnstone, 1901). Its mode of occurrence in the intestine and its life history are, however, markedly similar, and it seems probable that both Mavor and Linton were dealing with the same parasite as that discussed in this paper.

A form which in both size and occurrence corresponds almost exactly to the one I have described, was found by Weissenberg in the European smelt, *Osmerus eperlanus,* and named *Glugea hertwigi*. The dimensions given for this form are 4.6 to 5.4 by 2.3 μ, which measurements are very close to those of the American form. Weissenberg's measurements were taken from fresh specimen, which may account for their slightly larger proportions. The occurrence of the same parasite in European and American species of the smelt would furnish an interesting parallel to the case of *Myxidium lieberkuehni* which according to Mavor occurs in both the European and the American pike.

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Explanation of Plate

1. Smelt showing advanced infection of liver and intestine. Reduced one fifth.

2. Cross section of intestine showing an early infection. 20 ×.

3. Portion of parasitized testis. Objective: *32* mm. Eyepiece: 6 ×.

4. Periphery of developing cyst showing giant nuclei and developmental stages. Objective: 1.5 mm. Eyepiece: 10 ×.

5. Spores. Objective: 1.5 mm. Eyepiece: 15 ×.